Bowhead Whale 'SNACS' near Barrow, Alaska: a study of environmental & anthropogenic variability

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SNACS Team:

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National Science Foundation: Study of the Northern Alaska Coastal System (SNACS) program

Who are we?

- Carin Ashjian (WHOI)
- Bob Campbell (URI)
- Craig George (NSB)
- Craig Nicolson (UMASS)
- Jack Kruse (UAF)
- Wieslaw Maslowski (NPS)

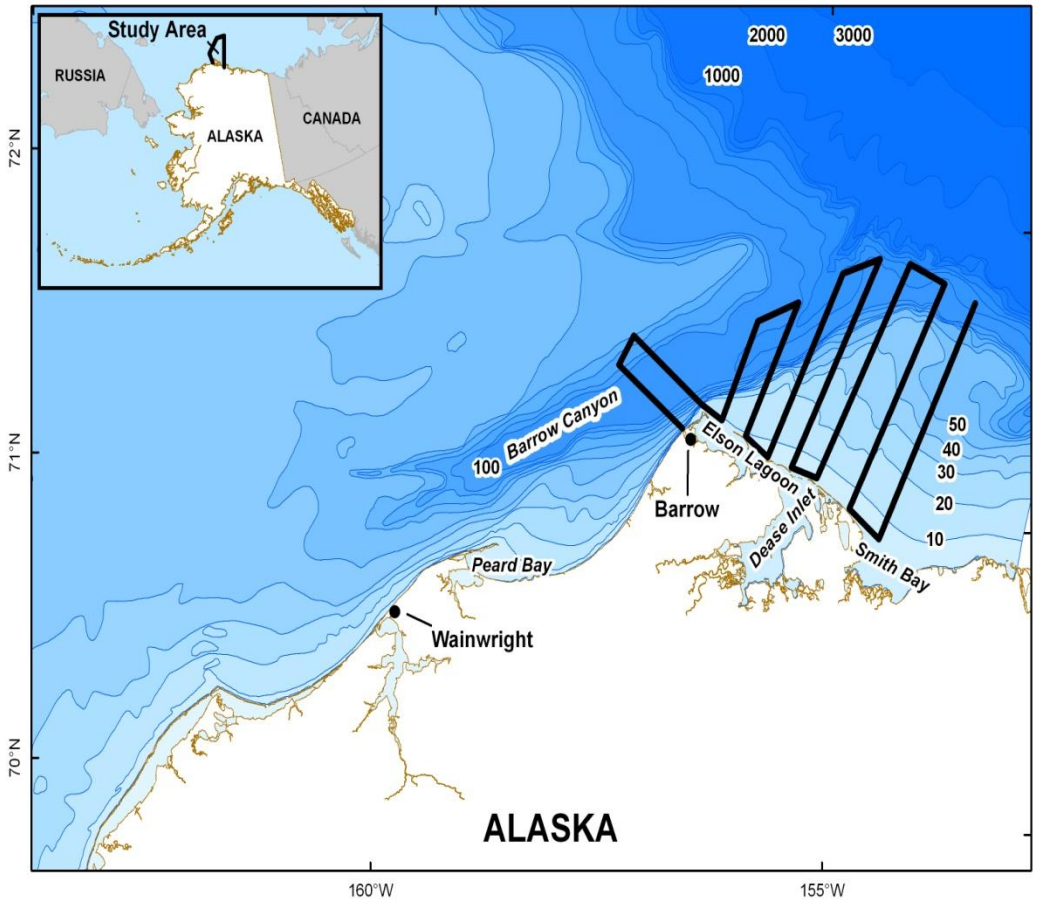
student - Jackie Clement

- Sue Moore (NOAA)
- Steve Okkonen (UAF)
- Steve Braund (B & Assoc.)
- Barry Sherr (OSU)
- Ev Sherr (OSU)
- Yvette Spitz (OSU)

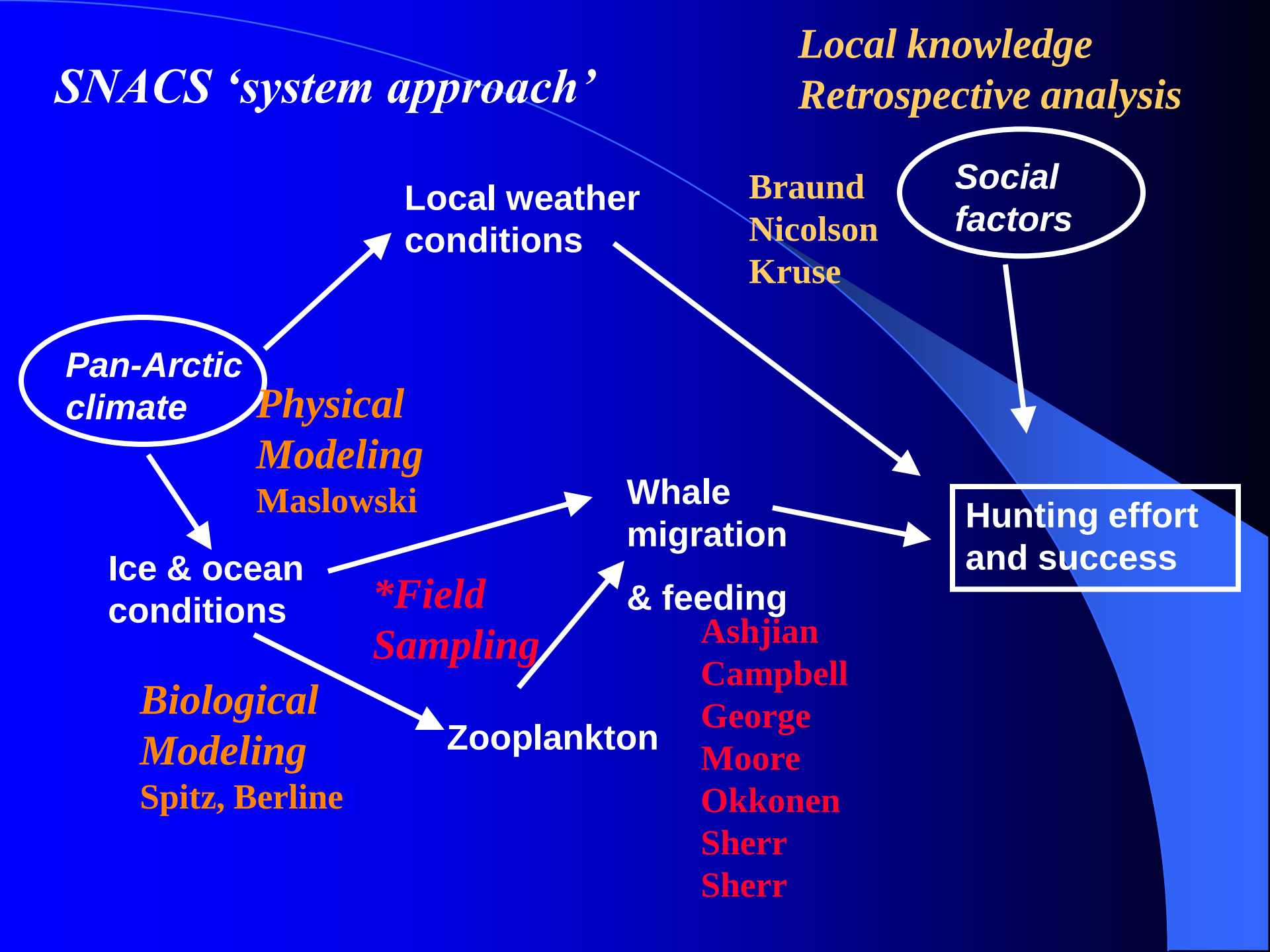
Post-doc – Leo Berline

- Barrow Arctic Science Consortium (BASC)
- The people of Barrow, whalers & families

What are we trying to do?



- **Characterize the biophysical and anthropogenic factors that result in bowhead whale feeding and Native Alaskan fall whaling opportunities near Barrow, Alaska.**
- **NSF 'System Science'**


SNACS 'system approach'
Local knowledge
Retrospective analysis
Braund
Nicolson
Kruse
Social factors
Local weather conditions
Pan-Arctic climate
Physical Modeling
Maslowski
Whale migration
& feeding
Hunting effort and success
Ice & ocean conditions
*Field Sampling
Ashjian
Campbell
George
Moore
Okkonen
Sherr
Sherr
Biological Modeling
Spitz, Berline
Zooplankton

OUTLINE

- **Background**
  - **Bowhead Basics**
  - **Migration & Humans**
- **SNACS***
  - **Tracking Environmental variability, 2005-06**
  - **A Window on a Coastal Arctic Ecosystem**

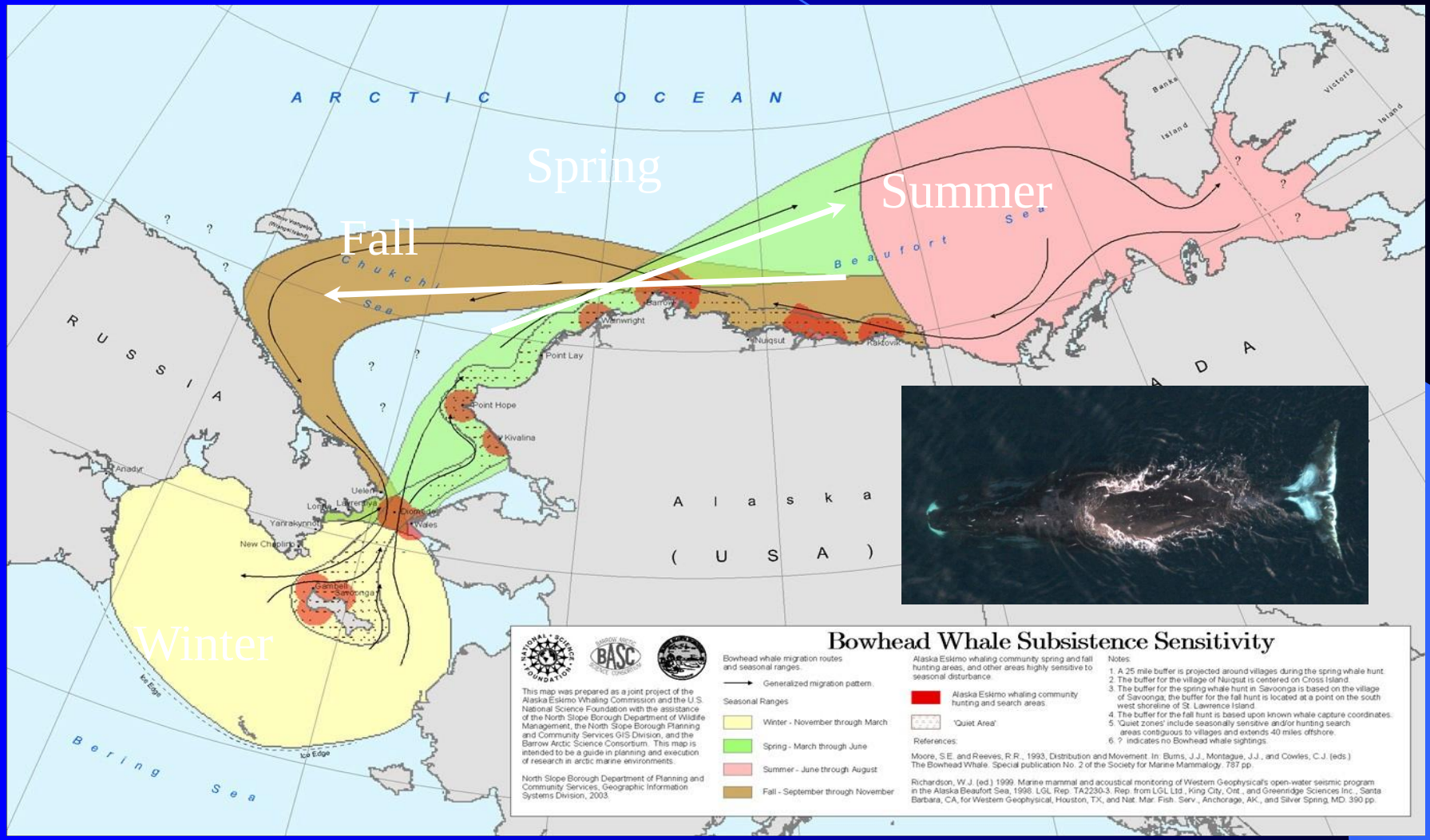

photo by Sue Moore

Bowhead Basics

- **Only** Arctic Mysticete
  Long-lived (100+ years)
  Large (to 19m); head 1/3 body
  Ice-Breakers (to 18 cm)
  Longest baleen (to 4m; 300 plates/side)
  Focus of intense commercial whaling
  1848 to ~1920
  Focus of subsistence hunt 1000s years
  Five Recognized Populations
  ****B-C-B* Pop.** Largest ~10,000 whales

[SNACS `05 Photo: Craig George]

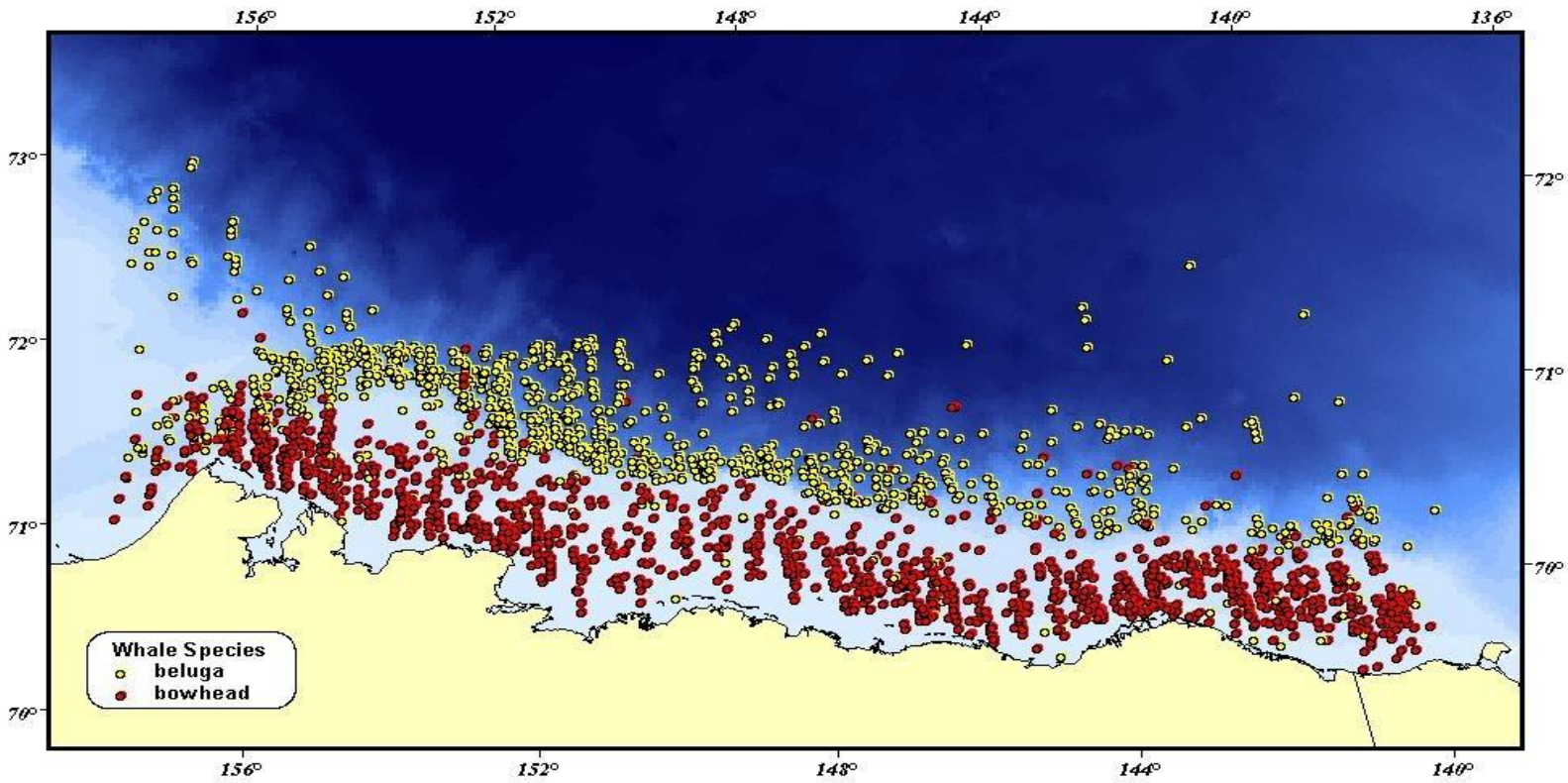
Bowheads migrate between the northern Bering and eastern Beaufort seas: exposure to human activities



Bowhead whaling is *key* to Inuit culture…& to zooplankton sampling

photo by Sue Moore

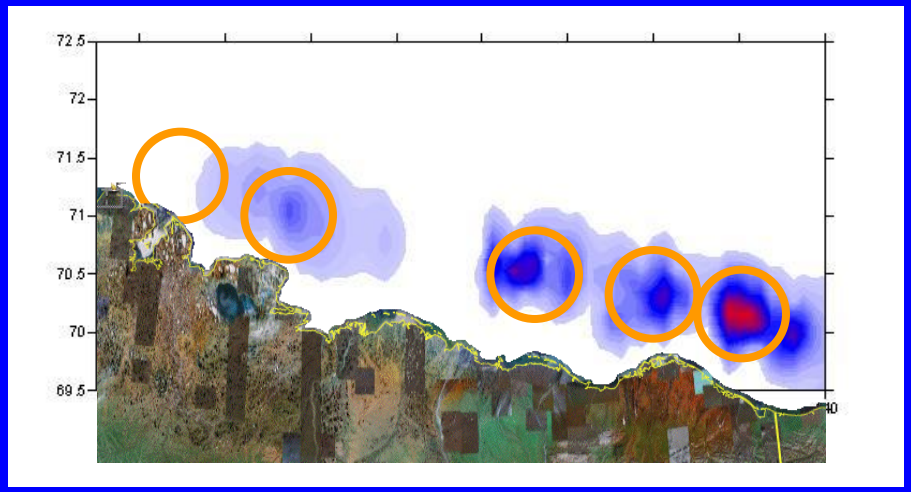
Fall surveys re. Oil & Gas exploration = *key* to western culture

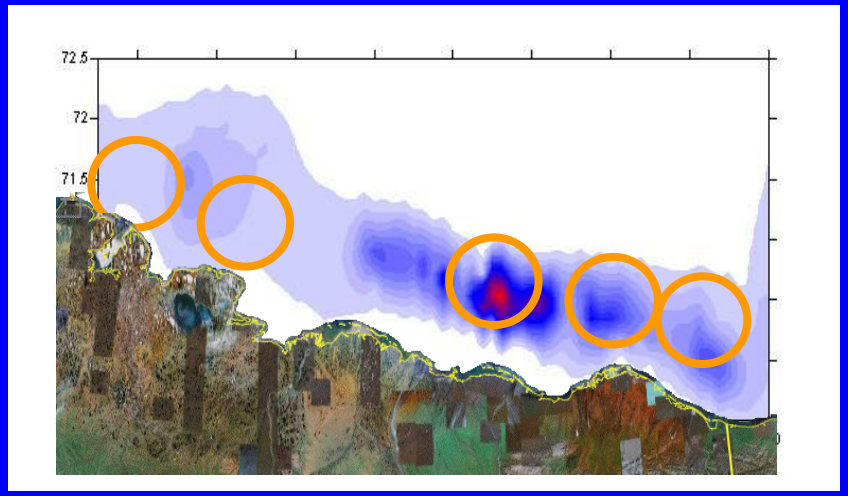


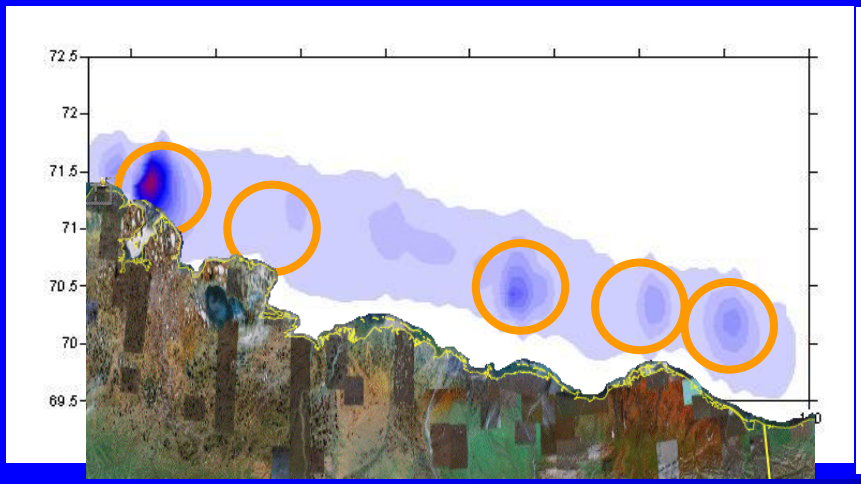
During 1980s, whales aggregated near Barrow to feed in some years

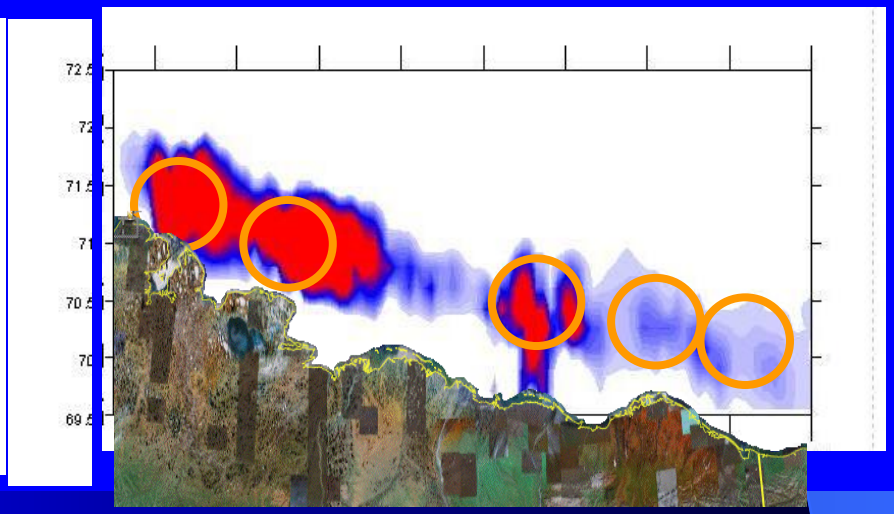
photo by Sue Moore

‘Hotspot Analysis’ of Bowhead Whale Aerial Survey(BWASP) Data, 1988-2004: Whale Sighting Density (C. Nicolson: 1990 & 1995-7)









MMS BWASP data suggest waters near Barrow may be more important now than in the 1980s.

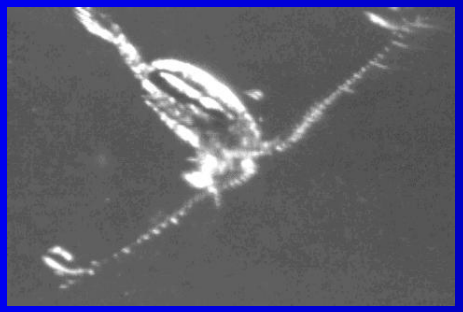
SNACS Hypotheses

- **Bowhead whales aggregate near Barrow in fall to feed on dense zooplankton patches that form there**
- **Feeding bowheads facilitate Native subsistence fall whaling**

Questions

- **What are the oceanographic conditions that make this a favorable feeding environment?**
- **How might climate variability change the locations of good feeding spots and hence whale migration behavior ?**
- **How might these climate associated changes impact whaling success and hence the whaling tradition in the Northern Alaska coastal communities?**

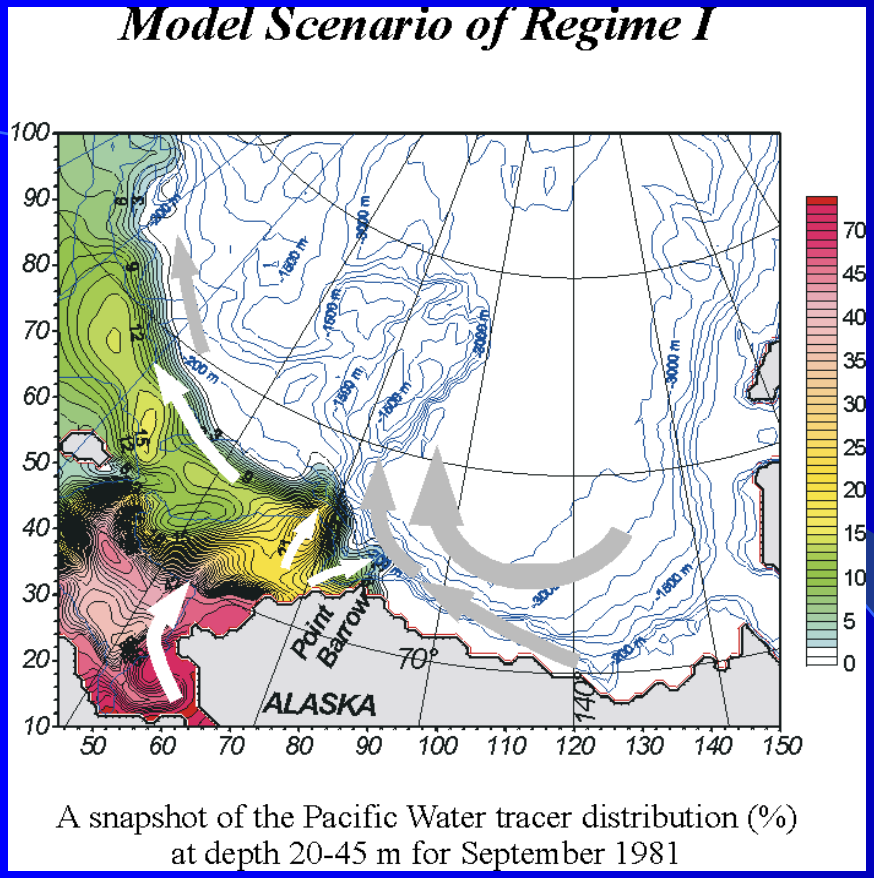
Bowhead Prey

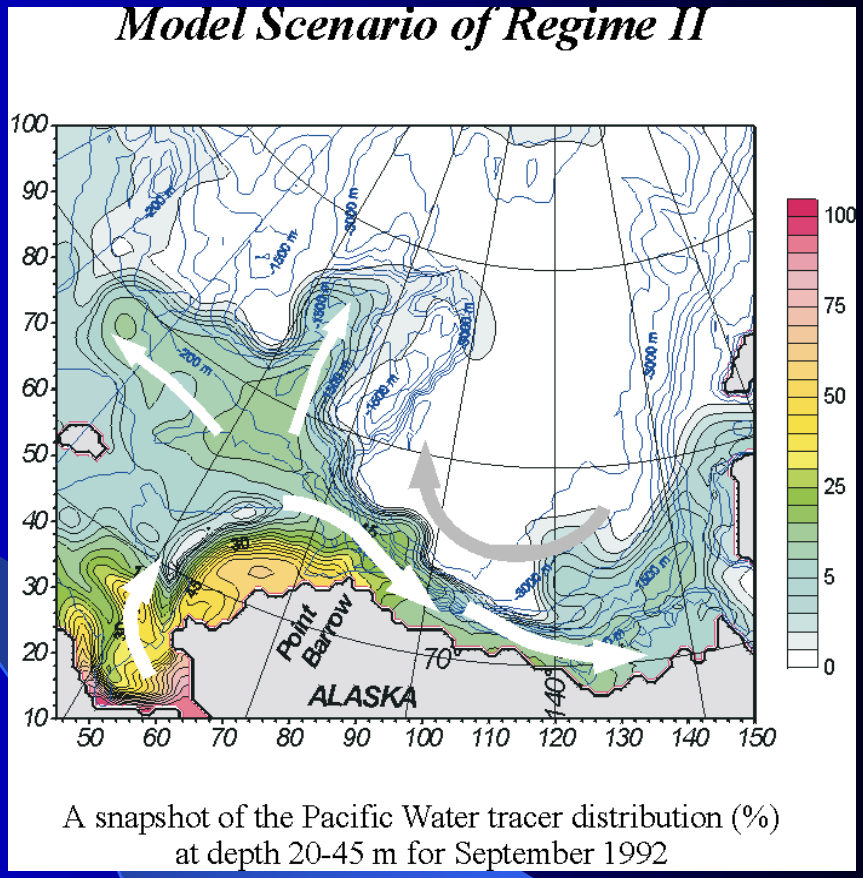


Copepods - Arctic and Pacific

Euphausiids/Krill - Pacific

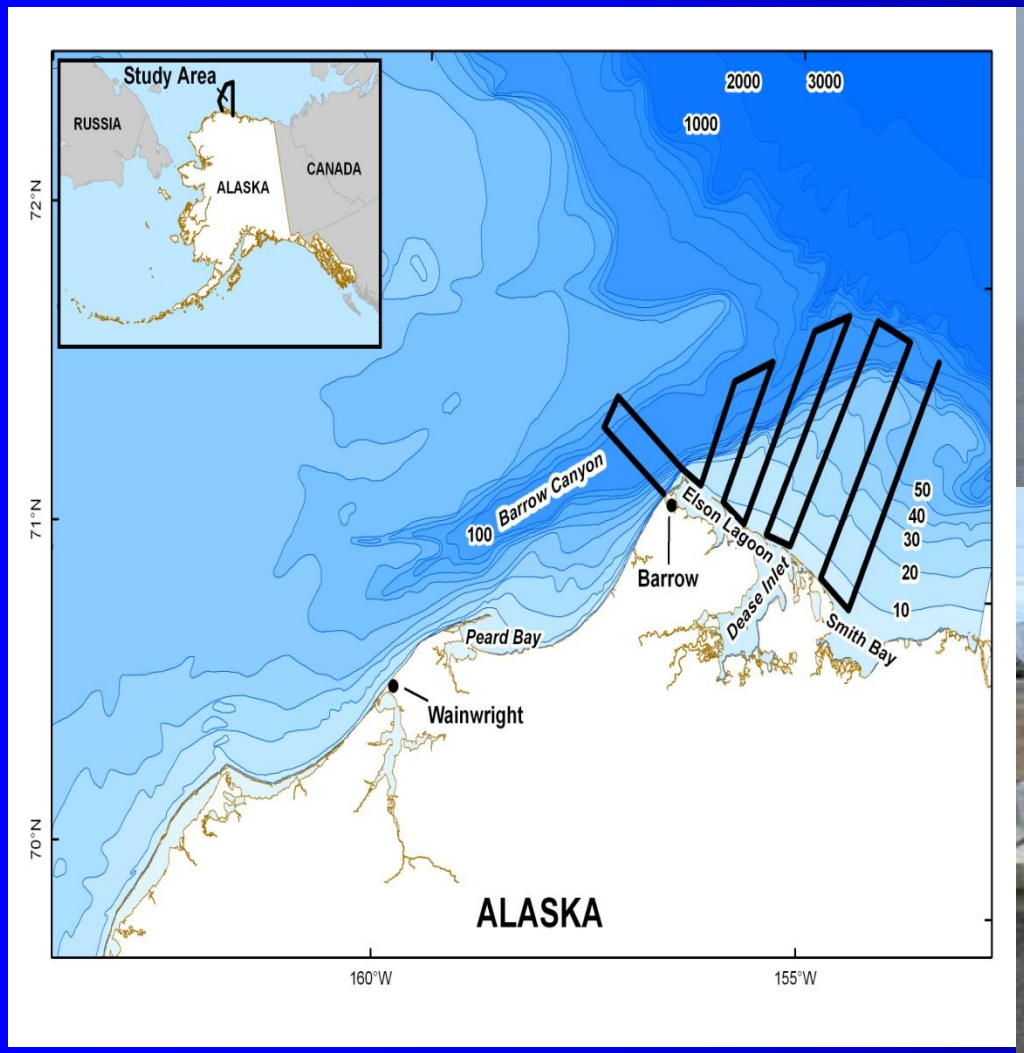
AO Model: two climate regimes





- **Regime I**: less Bering Sea Water, greater influence of Beaufort Sea gyre near shore and Arctic water (over-wintering copepods)
- **Regime II**: more Bering Sea Water (advects euphausiids) extending along Beaufort Shelf to Kaktovik

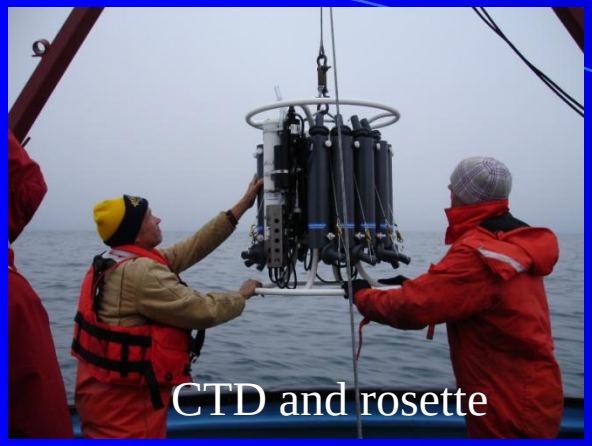
Field Sampling: Transects



Air and sea surveys: 2005 and 2006

- **Oceanographic sampling using the 43' *R/V Annika Marie* from mid-August to mid-September**
- **Aerial surveys to document distributions of bowhead whales in early September**

Oceanographic Measurements


CTD and rosette


"Acrobat"

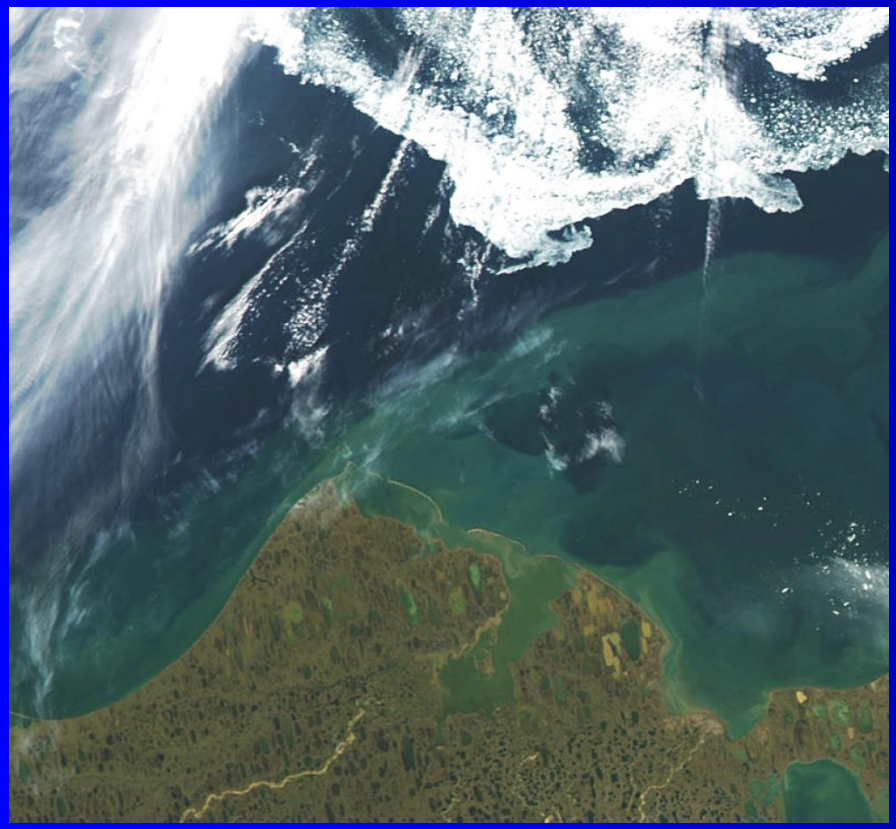

Deploying Acrobat

- **ACROBAT** - Temperature, salinity, pressure, optical backscatter, chlorophyll and CDOM fluorescence -VERY HIGH horizontal and vertical resolution (0-60 m)
- **CTD and Rosette** - Temperature, salinity, pressure, fluorescence, water for chlorophyll, nutrient, and microzooplankton determinations
- **ADCP (not shown)** - Velocity and acoustic backscatter
- **Plankton nets**

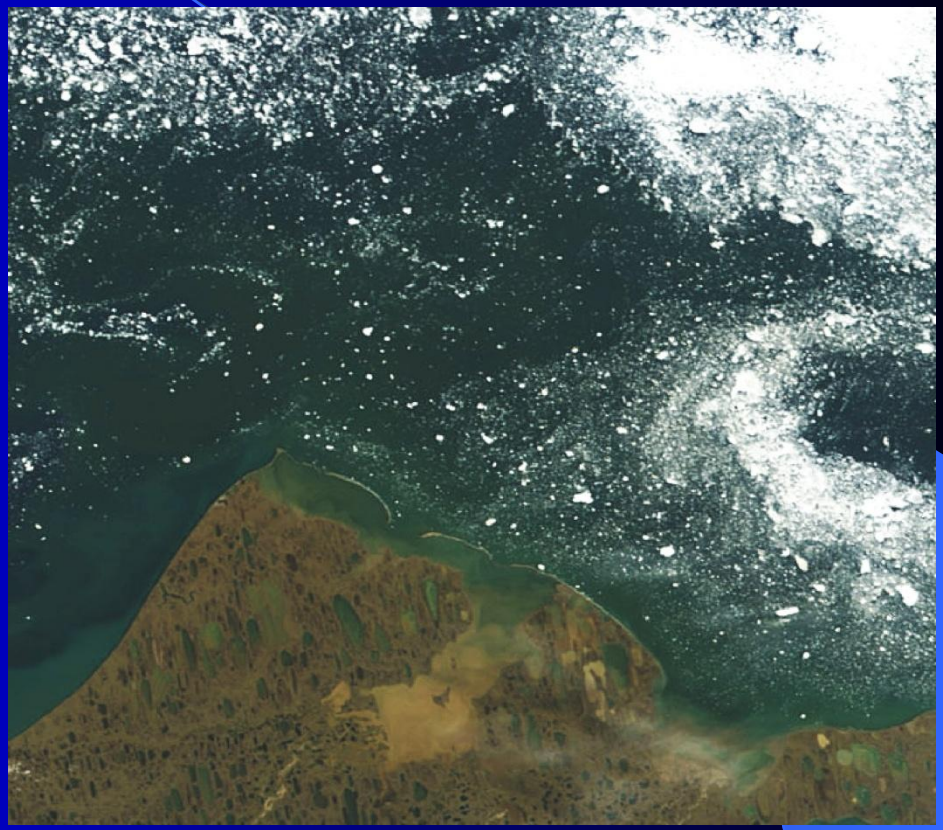

Nets

Satellite - Ice Cover

14 August 2005

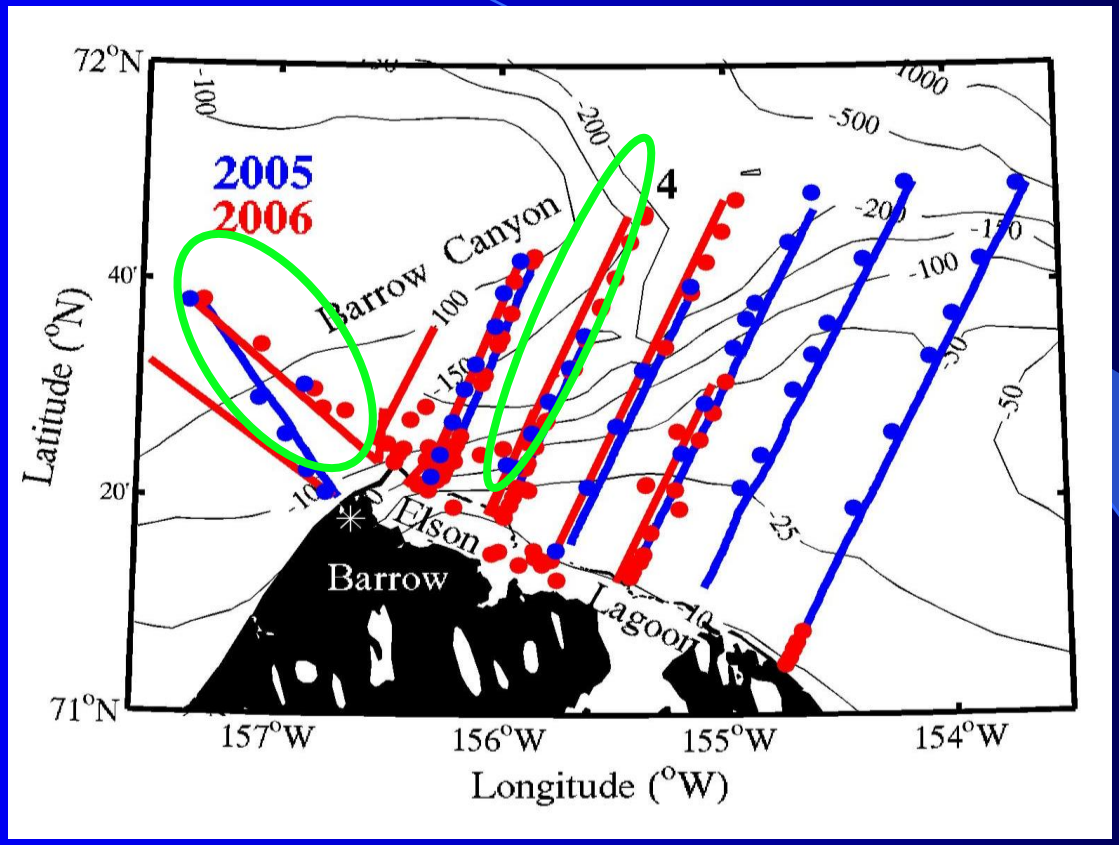


23 August 2006



- **Much more ice in 2006 than in 2005**

Oceanographic Sampling



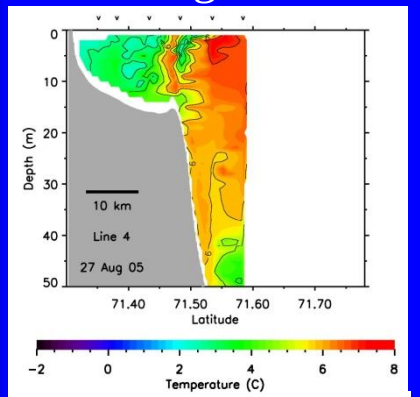
- Underway sampling along solid lines; discrete stations at symbols
- Areal coverage limited in 2006 relative to 2005 because of ice cover offshore and to the east

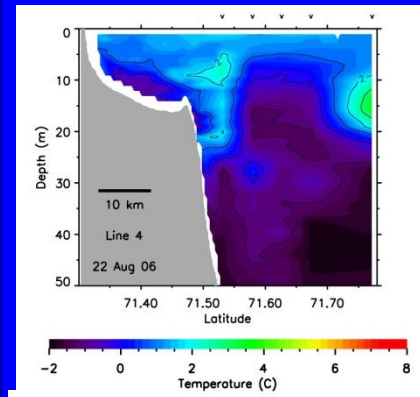
Hydrography along Transect 4

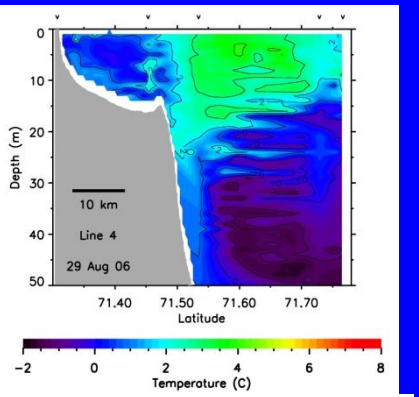
2005 | **2006**

Aug. 27 | Aug. 22 | Aug. 29

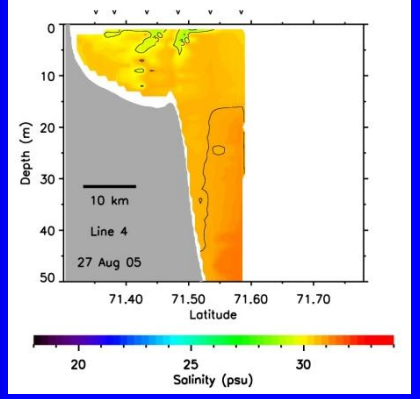
Temperature

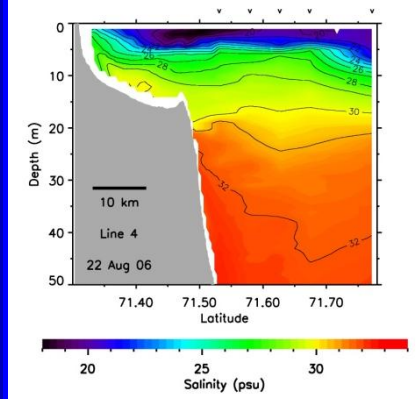


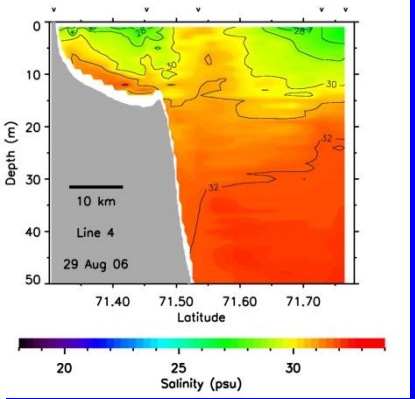




Salinity







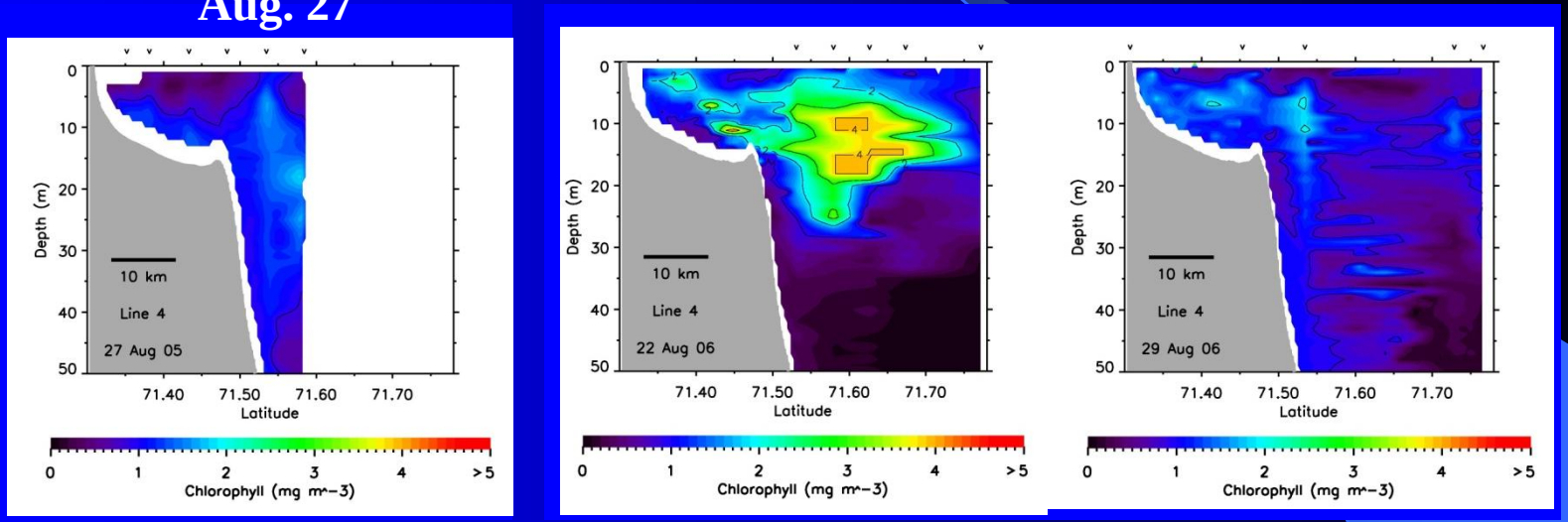
- Much colder, with much more vertical structure in salinity, in 2006 than in 2005
- Significant short term variability (days)

Chlorophyll Fluorescence along Transect 4

2005 **2006**

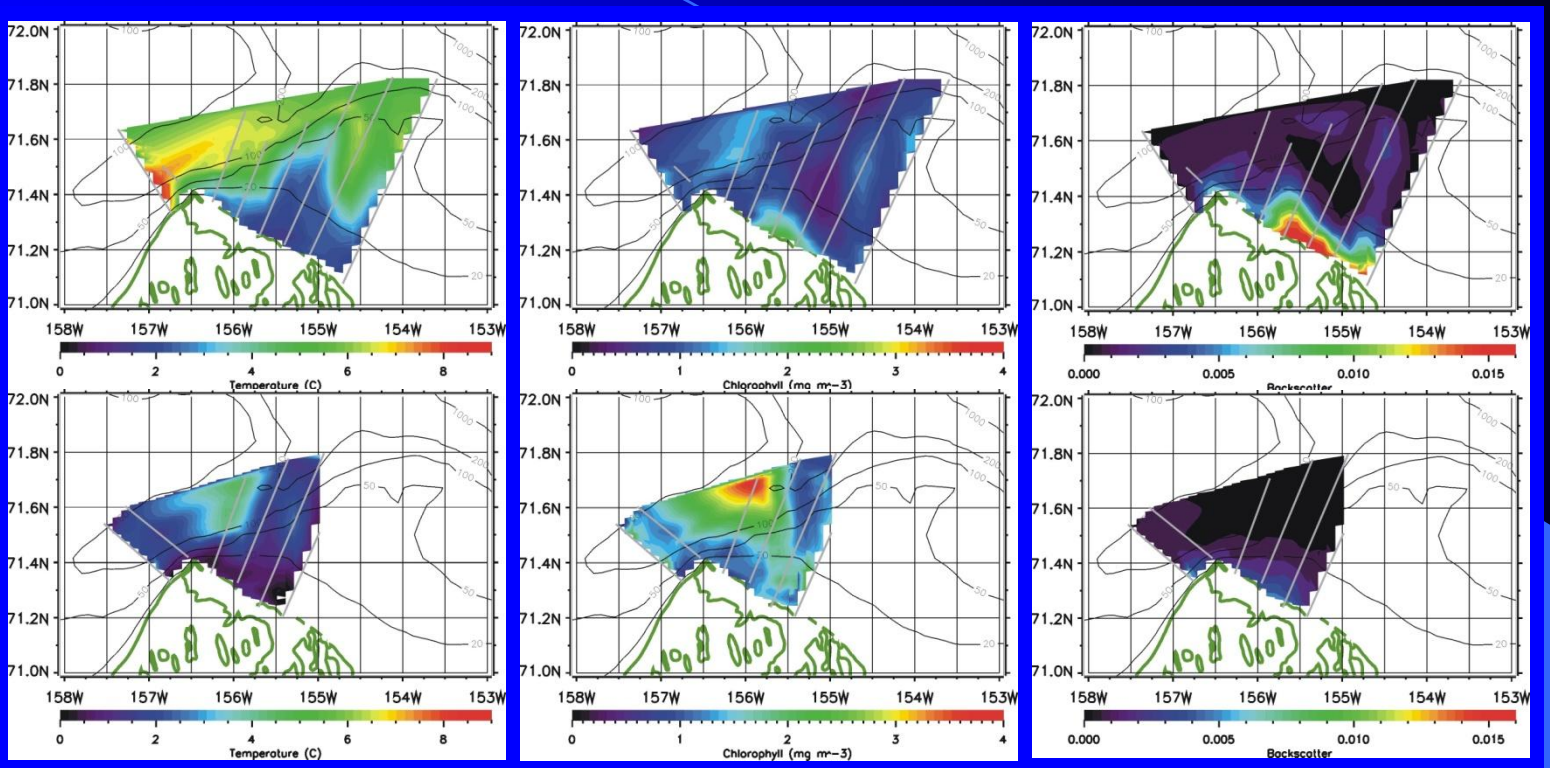
Aug. 27 **Aug. 22** **Aug. 29**

Chlorophyll



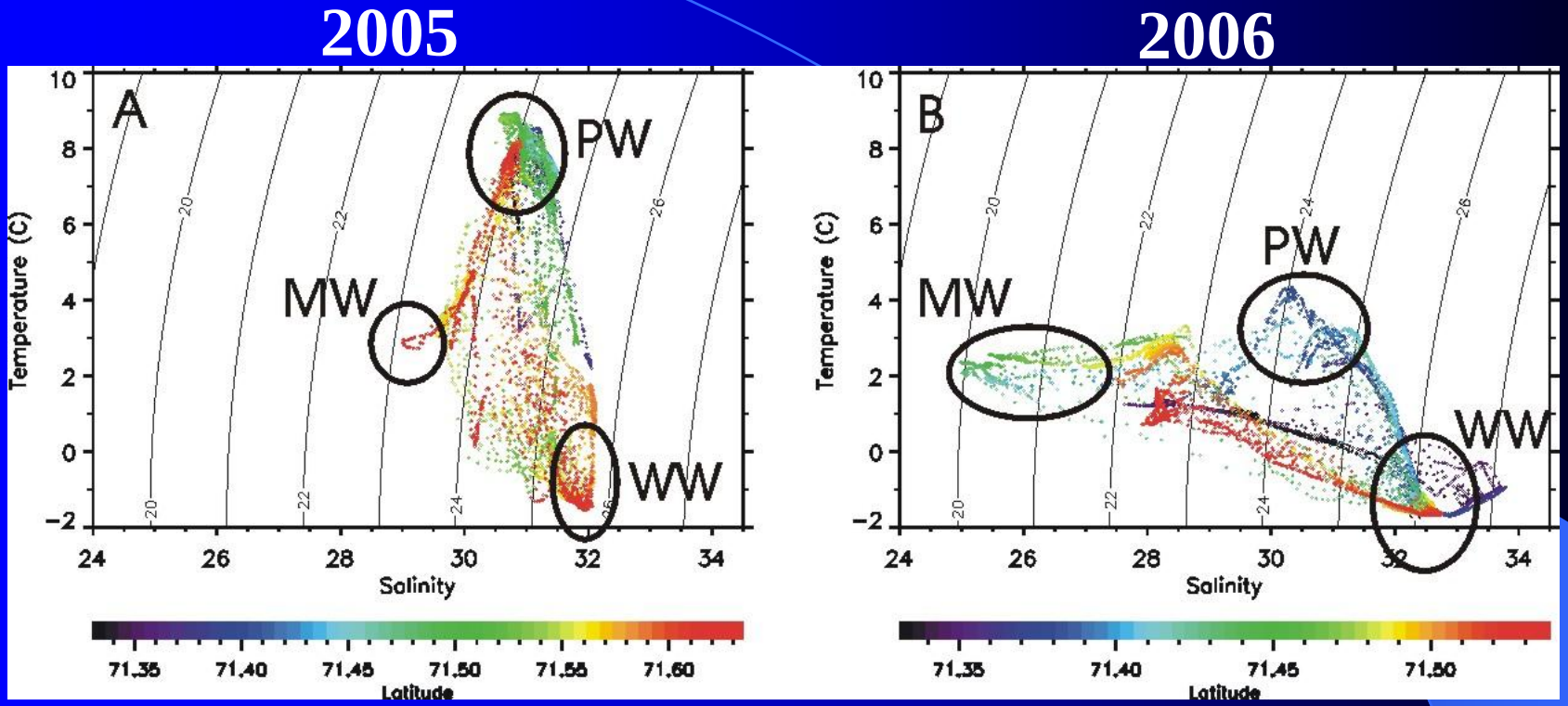
- Higher chlorophyll (plant pigment) in 2006 than in 2005
- With dramatic short-term variability, 2006

Properties at 7 m



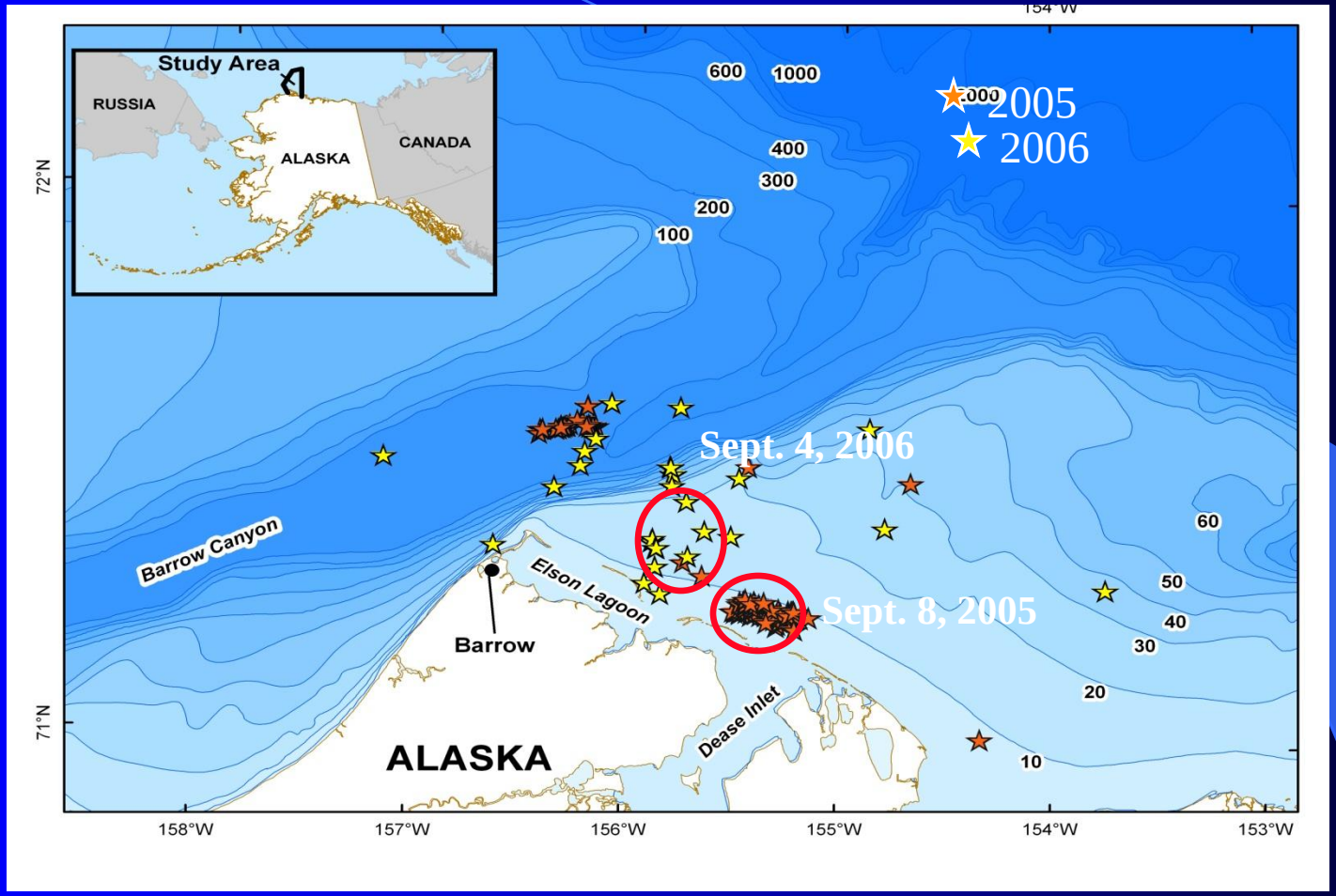
- Dramatic differences seen between years. Colder, with higher chlorophyll during 2006 than 2005. Much lower sediment load near outlet to lagoon system in 2006.
- Fronts and different water types present across the shelf.
- 2006 survey was mostly synoptic (4 days). 2005 survey was not (2-3 weeks)

Water Masses along Transect 1



- Three water types: Melt Water (MW), Pacific Water (PW), Winter Water (WW)
- Much cooler, slightly fresher PW in 2006 - mixed with MW
- Winter Water similar during both years
- Much fresher Melt Water (MW) in 2006 - more ice

Bowhead Whale Distributions

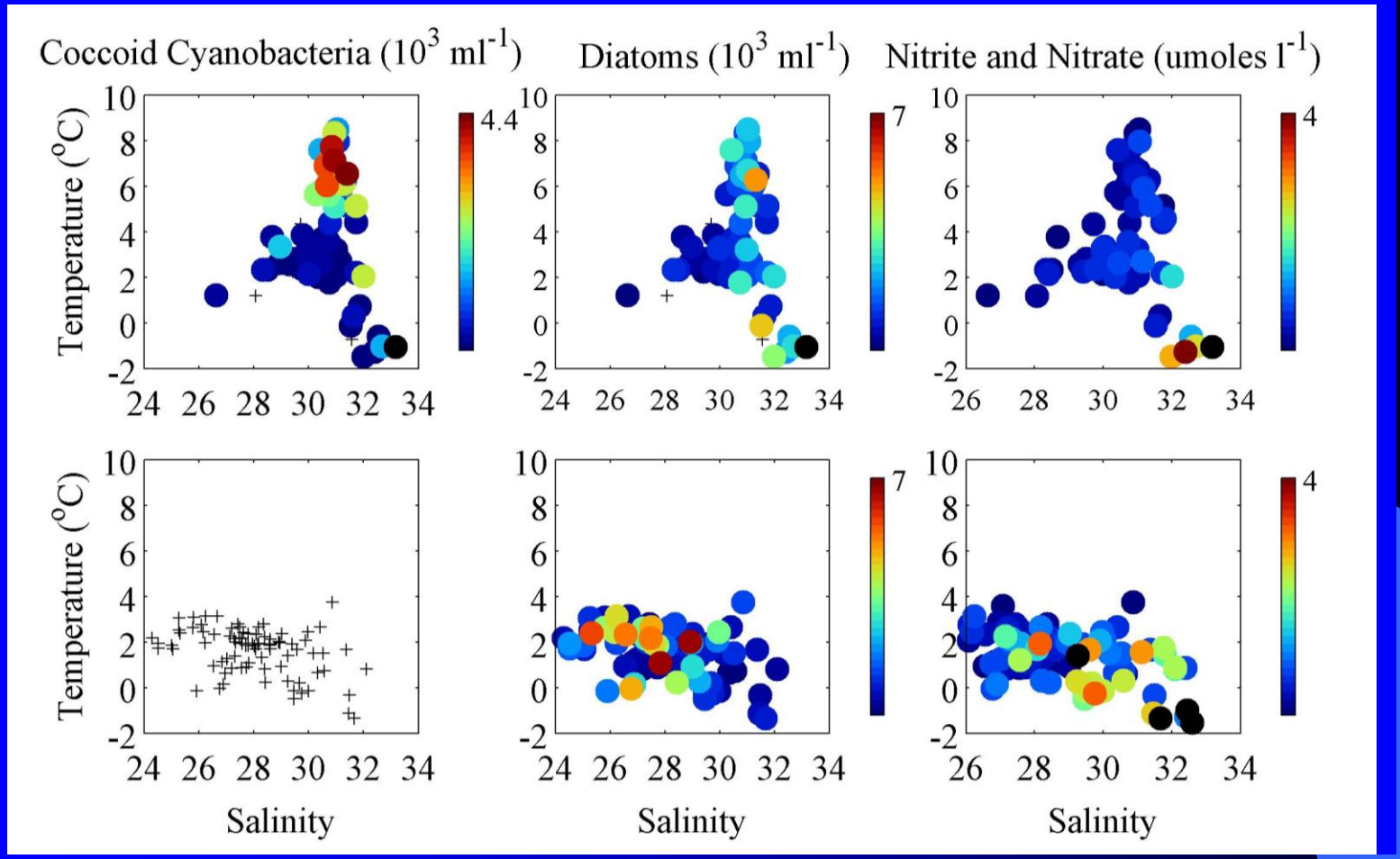


- **Whales observed in early September in both years**
- **Two locations of particular interest**

Biological Properties and Water Masses

2005

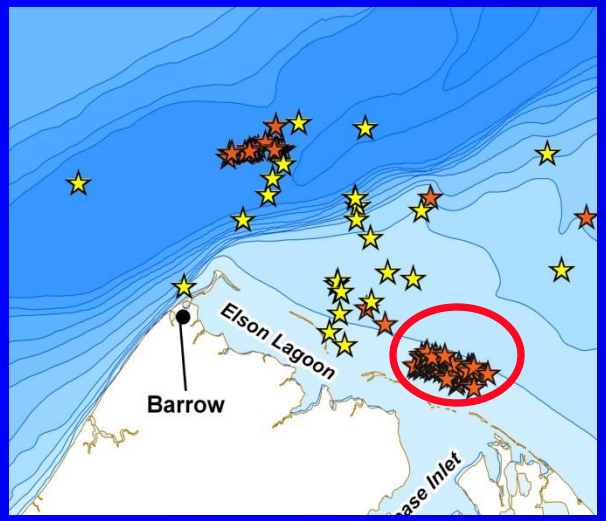
2006



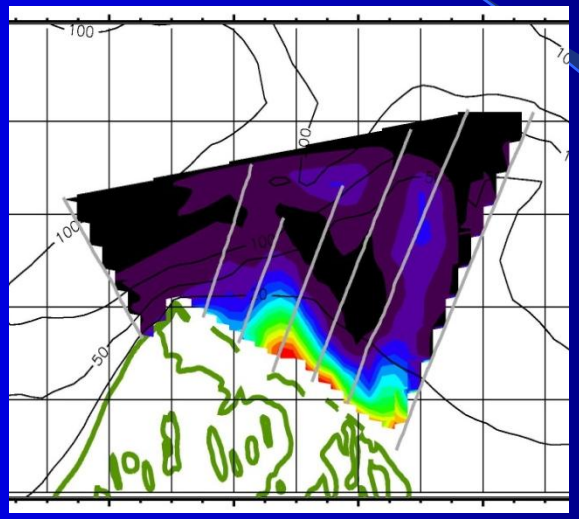
- **Nitrogen reduced** except for in deeper Winter Water in 2005, suggestive of a late season, heterotrophic food web.
- **Nitrogen elevated** in 2006, consistent with higher diatom and chlorophyll concentrations

2005 - Whales associated with the sediment plume off of Elson Lagoon

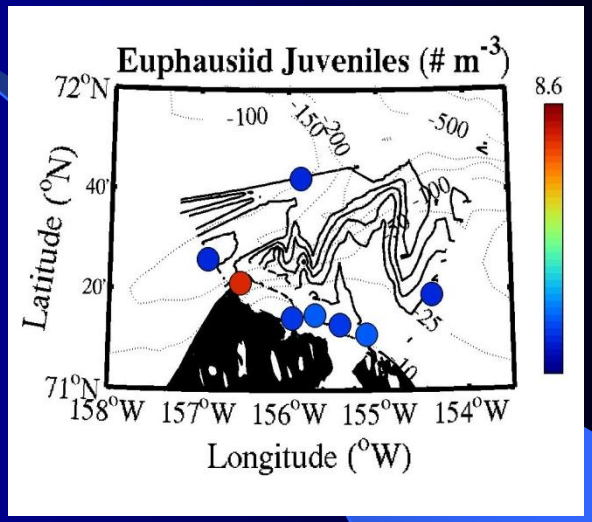
Whales



Sediment Plume



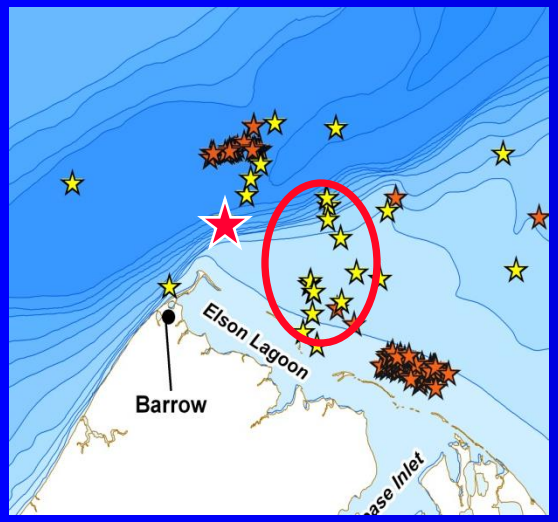
Krill Distribution



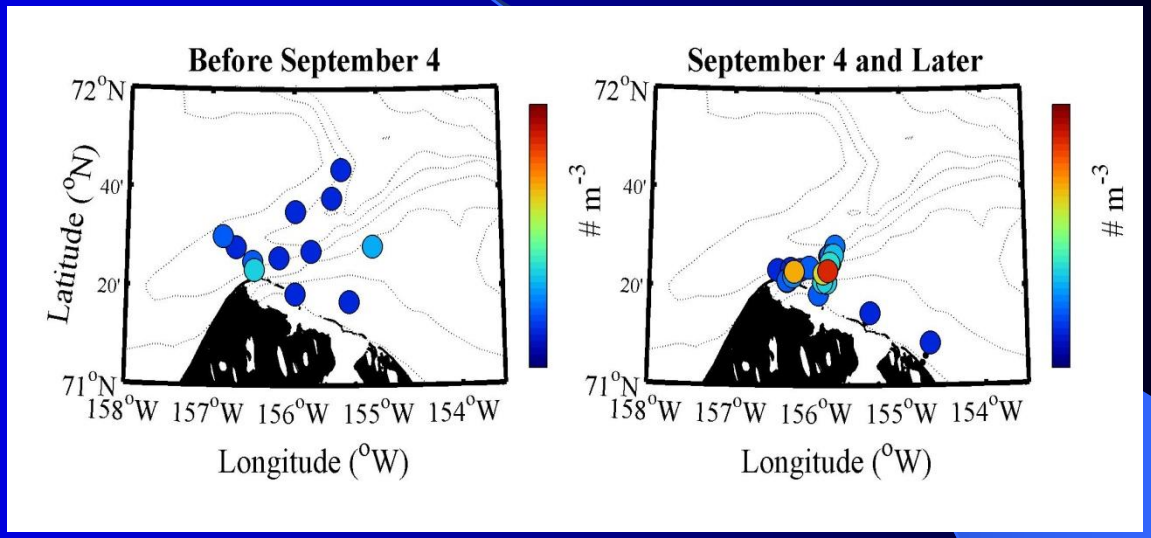
- **8 SEP -** Whales were observed just offshore of Elson Lagoon, in a association with the sediment plume
- Whales were congregating off of the barrier islands to feed on krill that were advected out of the Lagoon

2006 - Whales associated with high abundances of krill on shelf east of Barrow Canyon

Whales

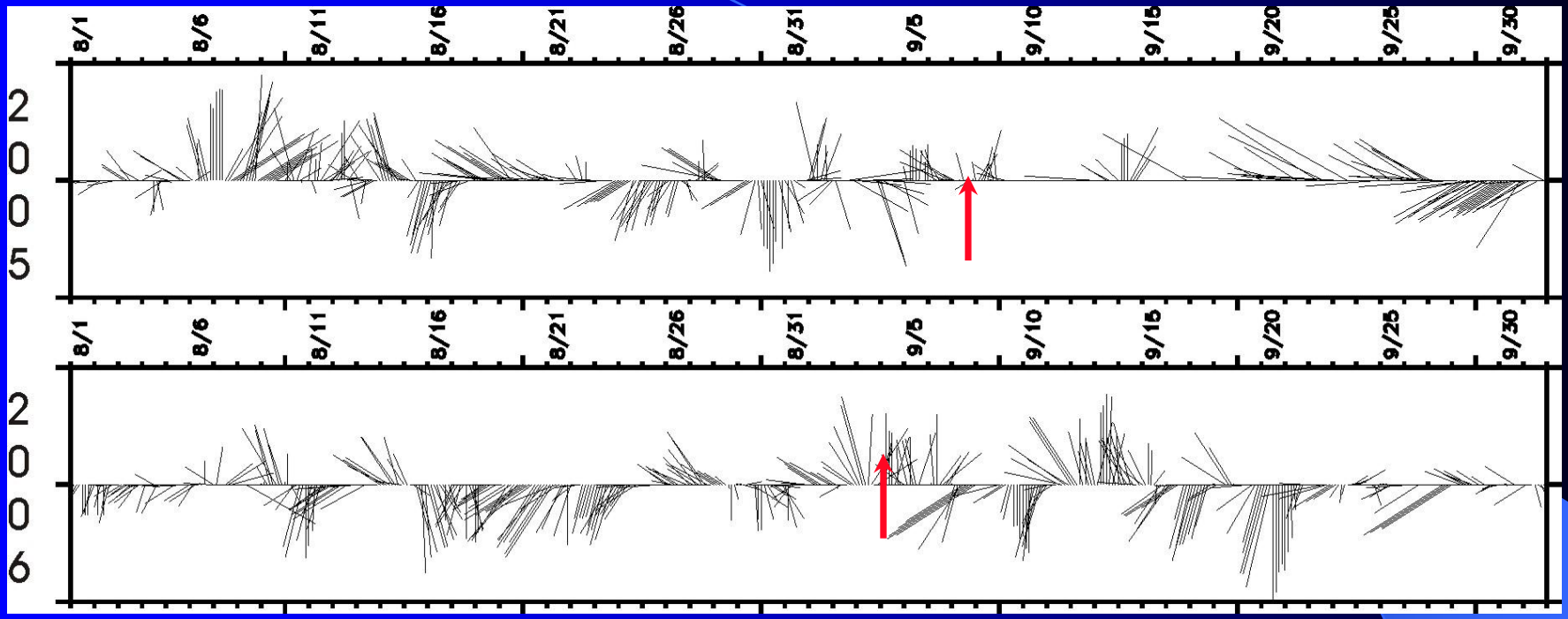


Krill Distribution



- **4 SEP** - Whales were observed to be feeding in a region of elevated krill abundance and acoustic backscatter
- **5 SEP** - Feeding whales were observed from the boat (**red star**), again in the region of elevated krill
- Region of elevated krill concentrated near Barrow

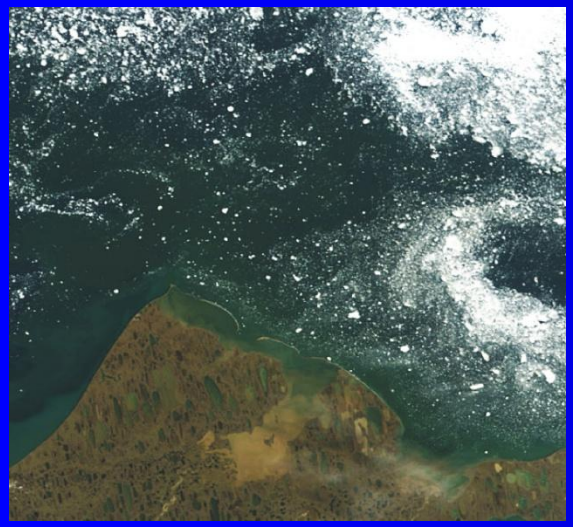
Winds at Barrow



- Both observations of feeding bowheads near krill occurred following period of southwest wind
- This prompted the generation of a hypothesis for how krill (whale prey) are upwelled onto the shelf

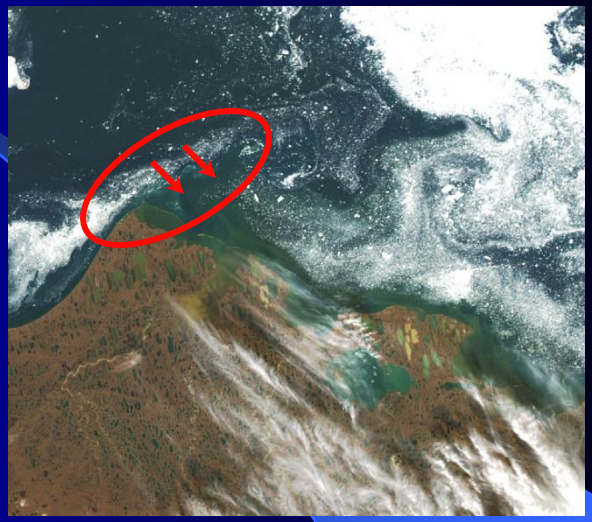
Working Hypothesis

August 23



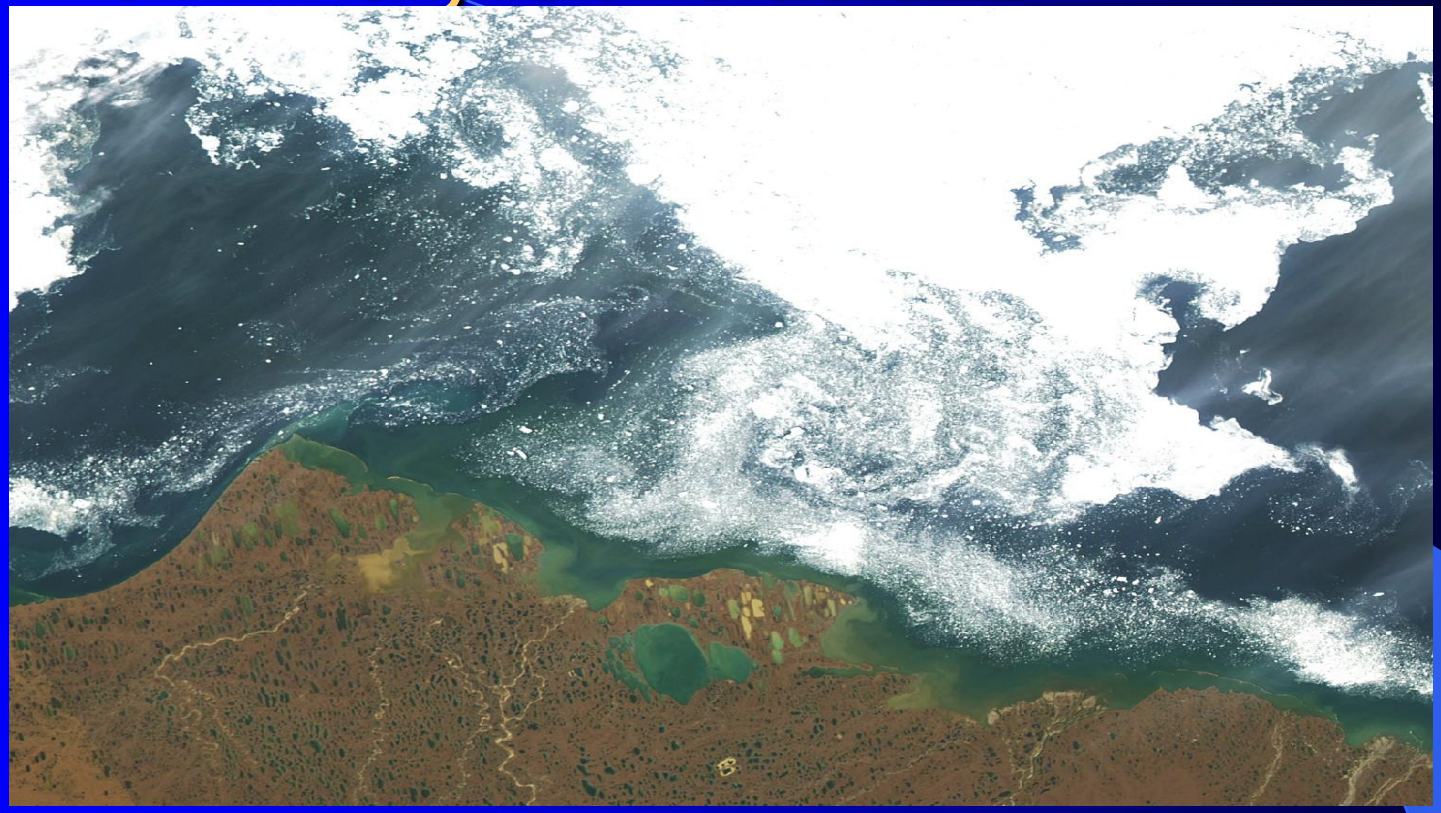
September 4

September 5



- Winds from the SW advect krill along Barrow Canyon and then via Ekman transport onto the shelf (2006)
- Sustained winds fill Elson Lagoon with krill that subsequently are drained from the lagoon to just offshore of the barrier island (2005)
- Elson Lagoon may function as a krill/plankton reservoir

Preliminary Conclusions



- These oceanographic surveys are the only high-resolution descriptions to date of the oceanography of the shelf near Barrow
- Multiple hydrographic zones and fronts associated with biological distribution were observed across the study area
- Striking between and within year variability in the physical (ice, ocean) and biological distributions. Much less Pacific Water was present, especially in the upper water column, during 2006 than during 2005.

Preliminary Conclusions (cont.)

- Short-term variability closely associated with the direction and strength of the wind
- Wind events may be significant in establishing a favorable feeding environment for the whales through transport of prey onto the shelf and into the lagoon
- Considerable longer term variability in the locations and intensity of bowhead whale aggregations is observed along the northern coast, although local knowledge indicates recurrent whale aggregations near Barrow
- During 2007, we will complete analysis of the oceanography and synthesize these results with the oceanographic modeling efforts and with the local knowledge and retrospective data analyses

SNACS: a window to Changes in Culture

Photo © Bill Hess

and Climate
Barrow – flat calm – SEP06

Acknowledgements

- Bill Kopplin, Ned Manning, and Mike Johnson, the captains of the *R/V Annika Marie*, for their valuable inputs to our program
- Chuck Monnett (MMS) for providing aircraft support and collaborating on the 2006 aerial survey
- The Barrow Whaling Captains Association, the Alaska Eskimo Whaling Commission, the North Slope Borough (especially the Dept. of Wildlife Management), and the community of Barrow for their support
- Glenn Sheehan and the Barrow Arctic Science Consortium Staff for logistic support in Barrow
- VECO Polar Services for logistic support in Deadhorse / Prudhoe Bay
- Bill Streever and Wilson Cullers at British Petroleum for assistance in accessing West Dock in Prudhoe Bay to load the *Annika Marie*
- The ARMADA Program at the University of Rhode Island for the participation of Jeff Manker and Kirk Beckendorf (high school teachers)
- Julie Mocklin (NMML) 2006 aerial surveys & maps
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